The injection molding device and method of the present invention overcomes the limitations associated with the prior art as briefly described above.

In accordance with one aspect, the present invention is directed to an injection molding device. The injection molding deivice comprising a cartridge assembly defining a chamber for housing a canister of premixed, one-to-one ratio mixture of thermoset elastomer, a cold deck nozzle assembly, the cartridge assembly being connected to the cold deck nozzle assembly through a one-way check valve and configured to inject thermoset elastomer from the canister into the cold deck nozzle assembly, the cold deck nozzle assembly comprising a manifold block with an internal passageway in fluid communication with the cartridge assembly and adapted to receive thermoset elastomer therefrom, and a cold deck nozzle in fluid communication with the internal passageway, and a micro plunger injection assembly connected directly to the cold deck nozzle assembly, the micro plunger injection assembly comprising a housing and a plunger moveable therein, the plunger configured to drive the thermoset elastomer through the internal passageway of the cold deck nozzle assembly and the cold deck nozzle, wherein the thermoset elastomer displacement for a single shot is substantially equal to the desired shot weight.

In accordance with another aspect, the present inention is directed to a meyhod for injection molding a component. The method comprising moving a premixed, one-to-one ratio mixture of thermoset elastomer from a cartridge assembly securing a canister of the thermoset elastomer into an internal passage of a cold deck nozzle assembly, and driving the thermoset elastomer through the internal passageway of the cold deck nozzle assembly and a cold deck nozzle, wherein the thermoset elastomer displacement for a single shot is substantially equal to the desired shot weight of the component.

The micro silicone mold mounted plunger injection unit or system in accordance with the present invention is configured as a cold deck system.

Fahrenheit) prior to being injected into a heated mold (340 to 410 degrees Fahrenheit). A runnerless molding system or cold deck is a device which allows for the equal distribution of material to each cavity at the same hydraulic pressure and consistent temperature profile. The raw materials utilized in the process are mixed in a one-to-one ratio, typically via the static mixer. Once the components come into contact, the curing process immediately begins. Accordingly, the cold drive is utilized to retard the curing process prior to the material being introduced into the heated mold. Essentially, the one-to-one mixed compound is pumped through the cold deck and then into a heated cavity where the vulcanization takes place. The cold deck and general cooling results in minimal loss of material as the injection occurs directly into the part, cavity or mold. This cooling process allows for the production of liquid silicone rubber parts with substantially zero material valve gate waste.

Silicone injection molding of micro sized components, such as punctal plugs or components of punctual plugs, in a conventional silicone injection molding machine is difficult due to the imbalance between the amounts of material flow relative to component volume. In other words, the high volume of material within the material flow path in conventional molding equipment is much greater than the volume of the micro sized components thereby eliminating the control system's ability to discern between filled and non-filled cavities.

The present invention is directed to a micro sized, plunger style, silicone injection unit that mounts directly into or onto a silicone mold along with a cold deck nozzle. The exemplary injection unit comprises a single material cartridge that feeds pre-mixed silicone directly through a one-way check valve into the plunger unit and the cold shut off nozzle of the cold deck mold. Pressure sensors/transducers mounted within the material flow path, as described in detail subsequently, and hard wired into the unit's control system monitor and control the injection sequencing and flow of the material through the injection unit. The plunger unit may comprise an electric motor, a pneumatically driven device or any other suitable means that is actuated by signals from the

Injection Type	Out total shot weight is **0.218gr**	Rod/ Screw "Area" (Cubic inches)	Material Displacement (cubic inches)	Material Displacement (Grams)
Plunger	Stroke **maximum** is **50mm**	0.0129		
	Stroke **minimum** is **1mm**	0.0129		
	Stroke **used** is **30mm**	0.0129		
	The 3mm diameter plunger has an area of	0.0129		
	Displacement of 3mm rod **@ 30mm stroke =**		0.0144	0.211
	Displacement of 3mm rod **@ 1mm stroke =**		0.0004	0.0066
	Displacement of 3mm rod **@ 50mm stroke =**		0.0214	0.3516
Recipro-cating Screw	A 12mm diameter reciprocating screw has an area of	0.752		
	Displacement of 12mm diameter screw @ 30mm stroke =		0.2069	3.3905

Table 1

Although shown and described is what is believed to be the most practical and preferred embodiments, it is apparent that departures from specific designs and methods described and shown will suggest themselves to those skilled in the art and may be used without departing from the spirit and scope of the invention. The present invention is not restricted to the particular

CLAIMS:

1. An injection molding device comprising:

a cartridge assembly defining a chamber for housing a canister of premixed, one-to-one ratio mixture able to form a thermoset elastomer;

a cold deck nozzle assembly, the cartridge assembly being directly connected to the cold deck nozzle assembly through a one-way check valve and configured to inject mixture from the canister into the cold deck nozzle assembly, the cold deck nozzle assembly comprising a manifold block with an internal passageway in fluid communication with the cartridge assembly and adapted to receive mixture therefrom, and a cold deck nozzle in fluid communication with the internal passageway; and

a micro plunger injection assembly connected directly to the cold deck nozzle assembly, the micro plunger injection assembly comprising a housing and a plunger moveable therein, the plunger configured to drive mixture through the internal passageway of the cold deck nozzle assembly and the cold deck nozzle, wherein the mixture displacement for a single shot is substantially equal to the desired shot weight.

2. The injection molding device according to claim 1, wherein the chamber of the cartridge assembly comprises a tubular member having a removable section for at least one of insertion or removal of the canister.

3. The injection molding deice according to claim 2, wherein the cartridge assembly further comprises a mechanism for driving mixture into the cold deck nozzle assembly.

4. The injection molding device according to claim 3, wherein the cold deck nozzle assembly further comprises a nozzle holding base, a cold nozzle holding block, and a chilling mechanism, wherein the nozzle holding base and the cold nozzle holding block secure the cold deck nozzle in position and allow for fluid communication between the cold deck nozzle and the internal passageway of the manifold block.

5. The injection molding device according to claim 4, wherein the chilling mechanism comprises a series of passageways for circulating cooling water.

6. The injection molding device according to claim 5, wherein the micro plunger injection assembly further comprises a plunger seal pack operatively associated with the plunger and an arrangement for moving the plunger to drive mixture through the internal passageway of the cold deck nozzle assembly and the cold deck nozzle and to a recharge position.

7. The injection molding device according to claim 6, wherein the micro plunger injection unit further comprises a shot stroke adjustment mechanism for setting the stroke length for a given shot.

8. The injection molding device according to claim 7, wherein the cold deck nozzle comprises a valve to open and close the cold deck nozzle.

9. The injection molding device according to claim 1, wherein the device further comprise a control system for controlling the operation of at least one of the cartridge assembly, the cold deck nozzle assembly and the micro plunger injection assembly.

10. A method for injection molding a component, the method comprising:

moving a premixed, one-to-one ratio mixture able to form a thermoset elastomer from a cartridge assembly securing a canister of the mixture directly into an internal passage of a cold deck nozzle assembly; and

driving mixture through the internal passageway of the cold deck nozzle assembly and a cold deck nozzle via a micro plunger assembly, wherein the mixture displace-ment for a single shot is equal to the desired shot weight of the component.

The injection molding device and method of the present invention overcomes the limitations associated with the prior art as briefly described above.

In accordance with one aspect, the present invention is directed to an injection molding device. The injection molding device comprising a cartridge assembly defining a chamber for housing a canister of premixed, one-to-one ratio mixture of thermoset elastomer, a cold deck nozzle assembly, the cartridge assembly being connected to the cold deck nozzle assembly through a one-way check valve and configured to inject thermoset elastomer from the canister into the cold deck nozzle assembly, the cold deck nozzle assembly comprising a manifold block with an internal passageway in fluid communication with the cartridge assembly and adapted to receive thermoset elastomer therefrom, and a cold deck nozzle in fluid communication with the interna! passageway, and a micro plunger injection assembly connected directly to the cold deck nozzle assembly, the micro plunger injection assembly comprising a housing and a plunger moveable therein, the plunger configured to drive the thermoset elastomer through the internal passageway of the cold deck nozzle assembly and the cold deck nozzle, wherein the thermoset elastomer displacement for a single shot is substantially equal to the desired shot weight.

In accordance with another aspect, the present invention is directed to a method for injection molding a component. The method comprising moving a premixed, one-to-one ratio mixture of thermoset elastomer from a cartridge assembly securing a canister of the thermoset elastomer into an internal passage of a cold deck nozzle assembly, and driving the thermoset elastomer through the internal passageway of the cold deck nozzle assembly and a cold deck nozzle, wherein the thermoset elastomer displacement for a single shot is substantially equal to the desired shot weight of the component.

The micro silicone mold mounted plunger injection unit or system in accordance with the present invention is configured as a cold deck system.

Fahrenheit or 16 to 25 degrees Celsius) prior to being injected into a heated mold (340 to 410 degrees Fahrenheit or 171 to 210 degrees Celsius). A runnerless molding system or cold deck is a device which allows for the equal distribution of material to each cavity at the same hydraulic pressure and consistent temperature profile. The raw materials utilized in the process are mixed in a one-to-one ratio, typically via the static mixer. Once the components come into contact, the curing process immediately begins. Accordingly, the cold drive is utilized to retard the curing process prior to the material being introduced into the heated mold. Essentially, the one-to-one mixed compound is pumped through the cold deck and then into a heated cavity where the vulcanization takes place. The cold deck and genera! Cooling results in minimal loss of material as the injection occurs directly into the part, cavity or mold. This cooling process allows for the production of liquid silicone rubber parts with substantially zero material valve gate waste.

Silicone injection molding of micro sized components, such as punctal plugs or components of punctual plugs, in a conventional silicone injection molding machine is difficult due to the imbalance between the amounts of material flow relative to component volume. In other words, the high volume of material within the material flow path in conventional molding equipment is much greater than the volume of the micro sized components thereby eliminating the control system's ability to discern between filled and non-filled cavities.

The present invention is directed to a micro sized, plunger style, silicone injection unit that mounts directly into or onto a silicone mold along with a cold deck nozzle. The exemplary injection unit comprises a single material cartridge that feeds pre-mixed silicone directly through a one-way check valve into the plunger unit and the cold shut off nozzle of the cold deck mold. Pressure sensors/transducers mounted within the material flow path, as described in detail subsequently, and hard wired into the unit's control system monitor and control the injection sequencing and flow of the material through the injection unit. The plunger unit may comprise an electric motor, a pneumatically driven device or any other suitable means that is actuated by signals from the

Injection Type	Out total shot weight is 0.218gm	Rod/Screw "Area" in^3 and (m^3)	Material Displacement in^3 and (m^3)	Material Displacement (Grams)
Plunger	Stroke **maximum** is **50mm**	0.0129 ($2.1139x10^{-7}$)		
	Stroke **minimum** is **1mm**	0.0129 ($2.1139x10^{-7}$)		
	Stroke **used** is **30mm**	0.0129 ($2.1139x10^{-7}$)		
	The 3mm diameter plunger has an area of	0.0129 ($2.1139x10^{-7}$)		
	Displacement of 3mm rod **@ 30mm stroke =**		0.0144 ($2.3597x10^{-7}$)	0.211
	Displacement of 3mm rod **@ 1mm stroke =**		0.0004 ($6.555x10^{-9}$)	0.0066
	Displacement of 3mm rod **@ 50mm stroke =**		0,0214 ($3.5068x10^{-7}$)	0.3516
Recipro-cating Screw	A 12mm diameter reciprocating screw has an area of	0.752 ($1.232x10^{-5}$)		
	Displacement of 12mm diameter screw @ 30mm stroke =		0.2069 ($3.3905x10^{-7}$)	3.3905

Table 1

Although shown and described is what is believed to be the most practical and preferred embodiments, it is apparent that departures from specific designs and methods described and shown will suggest themselves to those skilled in the art and may be used without departing from the spirit and scope of the invention. The present invention is not restricted to the particular

CLAIMS:

1. An injection molding device comprising:

a cartridge assembly defining a chamber for housing a canister of premixed, one-to-one ratio mixture able to form a thermoset elastomer the chamber of the cartridge assembly comprising a tubular member having a removable section for at least one of insertion or removal of the canister;

a cold deck nozzle assembly, the cartridge assembly being directly connected to the cold deck nozzle assembly through a one-way check valve and configured to inject mixture from the canister into the cold deck nozzle assembly, the cold deck nozzle assembly comprising a manifold block with an internal passageway in fluid communication with the cartridge assembly and adapted to receive mixture therefrom, and a cold deck nozzle in fluid communication with the internal passageway, the cartridge assembly further comprises a mechanism for driving mixture into the cold deck nozzle assembly; and

a micro plunger injection assembly connected directly to the cold deck nozzle assembly, the micro plunger injection assembly comprising a housing and a plunger moveable therein, the plunger configured to drive mixture through the internal passageway of the cold deck nozzle assembly and the cold deck nozzle, wherein the mixture displacement for a single shot is substantially equal to the desired shot weight.

2. The injection molding device according to claim 1, wherein the cold deck nozzle assembly further comprises a nozzle holding base, a cold nozzle holding block, and a chilling mechanism, wherein the nozzle holding base and the cold nozzle holding block secure the cold deck nozzle in position and allow for fluid communication between the cold deck nozzle and the internal passageway of the manifold block.

3. The injection molding device according to claim 2, wherein the chilling mechanism comprises a series of passageways for circulating cooling water.

4. The injection molding device according to claim 3, wherein the micro plunger injection assembly further comprises a plunger seal pack operatively associated with the plunger and an arrangement for moving the plunger to drive mixture through the internal passageway of the cold deck nozzle assembly and the cold deck nozzle and to a recharge position.

5. The injection molding device according to claim 4, wherein the micro plunger injection unit further comprises a shot stroke adjustment mechanism for setting the stroke length for a given shot.

6. The injection molding device according to claim 5, wherein the cold deck nozzle comprises a valve to open and close the cold deck nozzle.

7. The injection molding device according to claim 1, wherein the device further comprise a control system for controlling the operation of at least one of the cartridge assembly, the cold deck nozzle assembly and the micro plunger injection assembly.